

Amendments to the Claims:

Claim 1 (Currently Amended): An X-ray generating apparatus comprising:

an X-ray tube for generating, within a housing sealed into vacuum, an X-ray by focusing an electron emitted from a cathode into an anode target by way of a first grid electrode, a second grid electrode, and a focusing electrode;

grid voltage control means for controlling a grid voltage applied to said first grid electrode; and

pulse generating means for generating a pulse which changes from an OFF state to an ON state and maintains said ON state for a predetermined period of time;

wherein said first grid electrode is disposed on the focusing electrode side of said cathode, whereas said second grid electrode is disposed on the focusing electrode side of said first grid electrode; and

wherein said grid voltage control means has cathode current detecting means for detecting a cathode current and, in response to said pulse generated by said pulse generating means, applies a cutoff voltage to said first grid electrode when said pulse is in said OFF state so as to prevent said electron emitted from said cathode from reaching said anode target, and applies to said first grid electrode, in response to said pulse generated by said pulse generating means, a grid operating voltage adjusted such that said cathode current detected by said cathode current detecting means attains a predetermined value when said pulse is in said ON state.

Claim 2 (canceled)

Claim 3 (currently amended): An X-ray generating apparatus according to claim 2 claim 1, wherein said cathode current detecting means has a cathode current detecting resistor, connected to said cathode, for detecting said cathode current; and wherein said grid voltage control means has:

- a negative voltage generating section for generating a predetermined negative voltage;
- a pulse inverter for inputting said pulse generated by said pulse generating means and generating an inverted pulse in which said ON and OFF states of said inputted pulse are inverted;
- a first switch for inputting said inverted pulse generated by said pulse inverter and outputting, when said inverted pulse is in said ON state, said predetermined negative voltage generated by said negative voltage generating section;
- a reference voltage generating section for generating a reference positive voltage;
- a second switch for inputting said pulse generated by said pulse generating means and outputting, when said pulse is in said ON state, said reference positive voltage generated by said reference voltage generating section;
- an operational amplifier having one input terminal for inputting a voltage generated by said cathode current detecting resistor and the other input terminal for inputting said predetermined negative voltage outputted from said first switch and said reference positive voltage outputted from said second switch; and
- a grid voltage control circuit for controlling, in response to an output from said operational amplifier, said grid voltage applied to said first grid electrode.

Claim 4 (previously presented): An X-ray imaging apparatus comprising imaging means for capturing an X-ray transmission image formed upon irradiating an object to be inspected with an X-ray generated by an X-ray generating apparatus;

wherein said X-ray generating apparatus comprises:

an X-ray tube for generating, within a housing sealed into vacuum, an X-ray by focusing an electron emitted from a cathode into an anode target by way of a first grid electrode, a second grid electrode, and a focusing electrode;

grid voltage control means for controlling a grid voltage applied to said first grid electrode; and

pulse generating means for generating a pulse which changes from an OFF state to an ON state and maintains said ON state for a predetermined period of time;

wherein said grid voltage control means has cathode current detecting means for detecting a cathode current and, in response to said pulse generated by said pulse generating means, applies a cutoff voltage to said first grid electrode when said pulse is in said OFF state so as to prevent said electron emitted from said cathode from reaching said anode target, and applies to said first grid electrode, in response to said pulse generated by said pulse generating means, a grid operating voltage adjusted such that said cathode current detected by said cathode current detecting means attains a predetermined value when said pulse is in said ON state; and

wherein said imaging means receives said pulse generated by said pulse generating means and captures said X-ray transmission image when said pulse is in said ON state.

Claim 5 (previously presented) An X-ray inspection system comprising an X-ray generating apparatus, an X-ray imaging apparatus having imaging means for capturing an X-ray transmission image formed upon irradiating an object to be inspected with an X-ray generated by said X-ray generating apparatus; and object detecting means for detecting arrival of said object in an imaging area in said X-ray imaging apparatus;

wherein said X-ray generating apparatus comprises:

an X-ray tube for generating, within a housing sealed into vacuum, an X-ray by focusing an electron emitted from a cathode into an anode target by way of a first grid electrode, a second grid electrode, and a focusing electrode;

grid voltage control means for controlling a grid voltage applied to said first grid electrode; and

pulse generating means for generating a pulse which changes from an OFF state to an ON state and maintains said ON state for a predetermined period of time;

wherein said grid voltage control means has cathode current detecting means for detecting a cathode current and, in response to said pulse generated by said pulse generating means, applies a cutoff voltage to said first grid electrode when said pulse is in said OFF state so as to prevent said electron emitted from said cathode from reaching said anode target, and applies to said first grid electrode, in response to said pulse generated by said pulse generating means, a grid operating voltage adjusted such that said cathode current detected by said cathode current detecting means attains a predetermined value when said pulse is in said ON state;

wherein said pulse generating means has trigger signal outputting means for outputting a trigger signal according to said detection of said object by said object detecting means and

outputs said pulse when said trigger signal is outputted from said trigger signal outputting means;
and

wherein said imaging means receives said pulse outputted from the pulse generating
means and captures said X-ray transmission image when said pulse is in said ON state.

Claim 6 (canceled)

REMARKS

In the most recent Office Action, claim 3 is objected to as being dependent upon a canceled claim; and claims 1 and 3-5 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Skillicorn et al. (U.S. Patent No. 5,077,771) in view of Yahata et al. (U.S. Patent No. 4,734,924).

Applicants have amended claim 1 to differently recite the invention. Applicants have amended claim 3 so that it now depends on pending claim 1. Claims 1 and 3-5 are now pending. Applicants traverse the objections and rejections set forth in the most recent Office Action, at least for the following reasons.

Applicants have amended claim 3 so that it now depends on pending claim 1. Accordingly, Applicants respectfully request reconsideration and withdrawal of the objection to claim 3 as being dependent on a canceled claim.

Applicants traverse the rejections applied to the pending claims based on Skillicorn et al. and Yahata et al. More particularly, Applicants submit that these references, whether taken alone or in combination, do not disclose or suggest any of Applicants' claimed combinations wherein a grid voltage control means applies to a first grid electrode a grid operating voltage adjusted such that the cathode current detected by the cathode current detecting means attains a predetermined value when the pulse is in an ON state.

The Examiner agrees with this position insofar as it applies to Skillicorn et al. (See page 3 of the Office Action, last paragraph.) That is, the Examiner appears to agree that Skillicorn et al. does not disclose or suggest any such grid voltage control means. The Examiner nevertheless

asserts that Yahata et al. makes up for this deficiency. Applicants strenuously disagree with this assertion, at least for the following reasons.

In support of the assertion that Yahata et al. makes up for the deficiencies in Skillicorn et al., the Examiner apparently equates element 21 of Yahata et al. with the recited cathode current detection means and goes on to make the following statements (1) and (2):

(1) "It would have been obvious to one of ordinary skill in the art at the time the invention was made to have incorporated a cathode current detection means so that in response to a generated pulse, the grid voltage control applies a cutoff voltage to the grid electrode when pulse is in the OFF state so as to prevent electron emitted from the cathode from reaching the anode target and applies a grid operating voltage by a cathode current detecting means that detects a cathode current and is adjusted such that the electron emitted from the cathode so as to bombard the anode target attains a predetermined amount of quantity when the pulse is in the ON state (col. 2, line 58 – col. 3, line 29)."

(2) "One would be further motivated to include a cathode current detection means because it produces a second switching means for short-circuit detection as a result of current. This detection of an abnormal current at the sides of the x-ray tube, when detected, results in a noncoincidence between voltages across resistors to immediately opens [sic] the power source switch and filament switch and prevents x-ray projection (col. 2, line 58 – col. 3, line 29). A cathode current detection means assists the system in reducing malfunction as well as increase productivity control in ON and OFF states (col. 3, lines 8-29)."

The problem with statement (1) is that it is nothing more than impermissible hindsight reasoning. In Yahata et al., an abnormal current detection circuit 21 detects an abnormal current

at the anode and cathode sides with respect to x-ray tube 16. Upon occurrence of the abnormal state, the abnormal current detection circuit 21 sends an abnormal-state signal to protection circuit 22 which opens switches 11 and 20, in order to prevent x-ray projection. However, Yahata et al. does not anywhere disclose or suggest that a grid voltage control means applies to a first grid electrode a grid operating voltage adjusted such that a cathode current detected by a cathode current detecting means attains a predetermined value when a pulse is in an ON state, for example, to generate a stable x-ray from an x-ray tube. More particularly, this feature is not found in the passage of Yahata et al. cited by the Examiner (col. 2, line 58 – col. 3, line 29) or any other portion of this reference. Instead, this feature is only described in Applicants' own specification, and since it is not appropriate for an Examiner to rely on an Applicant's own specification in fashioning an obviousness rejection, Applicants submit that the rationale presented by the Examiner in statement (1) constitutes impermissible hindsight reasoning incapable of supported the asserted rejection.

As for statement (2), even if this statement were correct, it would fall short of providing adequate rationale for arguing that the claimed combination is obvious. Basically, statement (2) alleges that the use of cathode current detection means would have been obvious. Even assuming this were true, however, there is still no teaching in either of the cited references of a grid operating voltage adjusted such that the cathode current detected by the cathode current detecting means attains a predetermined value when the pulse is in the ON state. Thus, even if the applied references were to be combined in the manner suggested by the Examiner, the resulting combination would still not include all of the elements in the combinations recited in Applicants' independent claims 1, 4, and 5.

Claim 1 further distinguishes over references such as Yahata et al. In this regard, Yahata et al. discloses an x-ray tube 16 having an anode 16a, a cathode 16b, and a center metal electrode 16c. However, x-ray tube 16 of Yahata et al. does not appear to include a first grid electrode, a second grid electrode, and a focusing electrode. Accordingly, Applicants submit that this applied reference does not disclose or suggest the combination recited in claim 1 wherein said first grid electrode is disposed on the focusing electrode side of said cathode, and said second grid electrode is disposed on the focusing electrode side of said first grid electrode.

Furthermore, Applicants submit that in Yahata et al., the detection of an abnormal current flowing between the cathode and the center metal electrode when the ON signal is low level is accomplished by measuring voltage across a register (17a and 17b) by an abnormal current detection circuit (21). Thus, Yahata et al. does not disclose or suggest a cathode current detecting means having features such as recited in claim 1, for example.

For at least the foregoing reasons, Applicants submit that all of the pending claims patentably distinguish over the applied references to Skillicorn et al. and Yahata et al., whether taken alone or combined in the manner suggested by the Examiner. Accordingly, Applicants respectfully traverse all of the art-based rejections set forth in the pending Office Action and respectfully request reconsideration and withdrawal of all of the objections and rejections set forth therein. As all of the claims are now directed to allowable subject matter, Applicants respectfully request that the Examiner allow all of the pending claims and pass this case to issue.

CONCLUSION

In view of the foregoing, Applicants respectfully request reconsideration and the timely allowance of the pending claims. Should the Examiner feel that there are any issues outstanding after consideration of this response, the Examiner is invited to contact Applicants' undersigned representative to expedite prosecution. A favorable action is awaited.

If there are any other fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-0310. If a fee is required for an extension of time under 37 C.F.R. § 1.136 not accounted for above, such an extension is requested and the fee should also be charged to our Deposit Account.

Respectfully submitted,

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